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ABSTRACT

One-hundred twenty packages of computer programs, each package dealing with a single mathematical topic, are developed. Each package consists of three programs; the first gives the student a problem set, the second allows students to check answers, and the third composes a test. Topics range from addition of non-negative integers and other elementary topics to coordinate geometry, the binomial expansion, and other upper-level subjects. Experience indicates that even reluctant learners are motivated to use the system which is easy for both students and teachers to operate. (SD)

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Drill, Practice, and Testing Applications for the Reluctant Learner and Teacher of Mathematics: Elementary and Secondary

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The story you are about to hear originated in a local need. A number of school systems in North Carolina had gotten together to form a non-profit corporation called School Computer Service Corporation to provide economical computing for the instructional program and there was a need to supplement the practice exercises available to schools that were offering a course using the text A Second Course in Algebra and Trigonometry With Computer Programming.

Sets of three computer programs, written in the BASIC language, were produced. Under each topic the three programs were as follows:

- The first provided students with a set of problems. These were randomly produced so that no two students were likely to get the same set of problems.
- The second checked the work that the student had done by providing answers to his set of problems.
- The third tested and graded his knowledge of the topic. Again, no two students were likely to get the same problem.

Originally it was thought that teachers might develop their own "sets of three." Consequently, a pattern was developed that might be followed by a teacher. Experience has shown that teachers do not have the time that is needed for this work. However, the development of a "set of three" has been

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used very successfully as a project in college student seminars and teacher workshops where participants had very little previous experience of programming.

Over the past four years there has been an expansion to cover topics ranging from simple arithmetic through most high school algebra topics. There are now over 120 "sets of three." The programs are used in elementary schools, junior and senior high schools, and even in some colleges. Over the years, experience with the programs has resulted in refinement and personalizing of the programs as well as in instant feedback of the correct answer following an incorrect one in the tests.

Success has been particularly noteworthy among slow or reluctant learners. Many such students have been completely turned around as a result of using these programs. The following is an illustration of this type of success:

> A teacher of first year algebra found that she had a group of students in her tenth grade class who showed total disinterest even to the point of not turning in any work (including tests). It had been felt that they should have a mathematics course and this was the only one available at the tenth grade level.
>
> They were introduced to the terminal and became fascinated to the point that they would voluntarily go to the terminal room to work on their algebra. These students were often found working on their algebra for 45 minutes at a time and completely unsupervised. Prior to this, it is unlikely that any of them would have voluntarily worked for one minute on mathematics. They felt success, were making good grades, became eager to participate in class, and,

in addition, began to clean themselves up and dress more attractively. They soon eliminated their poor grades of the early weeks of the year and passed their course.

These students had not only felt success (evidently an element that had been lacking) but had gained some self-respect and, in taped interviews with some of them the following fall, they all strongly recommended that more teachers make use of the computer, and felt that without it they would not have passed their course. One who was interviewed volunteered the information that he thought that he would have forgotten everything by the fall but this was not so. He had run some of the tests and found that he was able to work the problems.

What happened to these students? Before getting involved with the computer it is unlikely that anyone would have given them jobs of responsibility. Following the computer experience, they were used as aides in the terminal room to assist their peers. and did a very fine job.

Experience has shown that, unfortunately, many teachers are reluctant to turn this type of student loose in the terminal room. Provided the orientation is handled carefully and the topic used in the orientation is simple enough for the student to succeed, there need be no fear.

Here is a list of the topics covered with the number of "sets of three" (varying in difficulty) under each topic:

TOPICS

	Number
Addition of Non-Negative Integers	9
Subtraction of Non-Negative Numbers	3
Multiplication of Non-Negative Integers	3
Division of Positive Integers	3
Finding All Pairs of Factors of Positive Integers	1
Addition of Decimals	5
Subtraction of Decimals	5
Multiplication of Decimals	4
Division of Decimals	4
Least Common Denominator	1
Greatest Common Divisor	1
Reduction of Fractions to Lowest Terms	2
Conversion of Fractions to Decimals	1
Addition of Fractions	3
Multiplication of Fractions	1
Percentages	1
Simple Interest	1
Addition of Signed Numbers	1
Subtraction of Signed Numbers	1
Multiplication of Signed Numbers	1
Division of Signed Numbers	1
Addition of Algebraic Expressions	1
Subtraction of Algebraic Expressions	1
Rounding Off Numbers	1
Writing Equations in Form $y=ax + b$	2
Finding Slope and Y-intercept Given Linear Equation	2
Finding Linear Equation Given Slope and Y-intercept	3
Grouping Symbols	1
Solving:	
Linear Equations	1
Linear Inequalities	1
Systems of Two Linear Equations	1
Systems of Three Linear Equations	2
Products of Binomials	1
Products of Trinomials by Binomials	1
Division of Polynomials	4
Factoring:	
Trinomials	3
Difference of Two Squares	1
Sum of Two Cubes	1
Difference of Two Cubes	1
Exponents	2
Quadratic Equations:	
Solving by Factoring	2
Solving by Completing the Square	2
Using the Discriminant	2
Vertex, Symmetry, Critical Value	1
Synthetic Substitution or Division	3
Analytics:	
Coordinates of Mid-Point of Line Segment	1
Slope of Line Segment Joining 2 Given Points	1
Slope of Perpendicular to Line Joining 2 Points	1
Equation of Perp. Bisector of Line Segment	1
Circles:	
Finding Center and Radius Given Equation	1
Finding Equation Given Center and Radius	1
Ellipses:	
Equation, Intercepts, Foci	1
Complex Numbers	6
Logarithms	5
Arithmetic Sequences	1
Geometric Sequences	1
Probability	1
Pth Term of Binomial Expansion	1
Determinant of 3 x 3 Matrix	1
Rational Roots of Cubic Equations	2
Trigonometric Ratios	1
Cartesian Products	1
Permutations	1
Combinations	1

Now let us take a specific set, the first in a series on multiplication of non-negative integers.

Here is a RUN of the problem program. You will note that the instructions are brief and include the name of the check program to be called on completion of the work. The student will have been informed that the asterisk is used to indicate multiplication.

```
MULTP1     10:45   WED.    10-20-76

FIND THE FØLLØWING 10 PRØDUCTS, THEN CALL  MULTC1***  AND
CHECK YØUR ANSWERS.

 1.  5 * 2      2.  4 * 8      3.  6 * 8      4.  7 * 6      5.  9 * 3

 6.  6 * 5      7.  1 * 4      8.  7 * 4      9.  8 * 8      10.  9 * 1
```

RUNS of the check and test programs follow.

The check program (MULTCI) has been modified here to fit on one page (checks only 8 of the answers). In the check program you will note that the student has the option of requesting instructions or not. The first time a student runs a program he is encouraged to answer "Yes"; thereafter, of course, he does not require the instructions. The comments at the end of the program are self-explanatory.

In the third in the set, the test, you will note the personalizing that occurs here. You may also note that the student is spoken to by name when he gives an incorrect answer - to soften the blow? This is hardly necessary if the answer is correct! A very important feature of the test is the instant feedback of the correct answer when a mistake has been made - a feature that is not available under more traditional test conditions. In this way the test is also a learning experience.

```
MULTC1    11:02   WED.   10-20-75

THIS PRØGRAM WILL CHECK YØUR ANSWERS TØ THE PRØBLEMS
THAT WERE GIVEN TØ YØU BY THE PRØGRAM  MULTP1*** .

DØ YØU NEED INSTRUCTIØNS?YES

IN ANSWER TØ THE QUESTIØN 'WHAT ARE THE FACTØRS IN THE
FIRST PRØBLEM?', IF THE PRØBLEM WERE 5 * 7 YØU WØULD TYPE
5,7 AND PRESS THE RETURN KEY.  THE CØMPUTER WØULD THEN
GIVE YØU THE CØRRECT ANSWER.


WHAT ARE THE FACTØRS IN THE FIRST PRØBLEM?5,2

YØUR PRØDUCT SHØULD BE:        10


NEXT PRØBLEM?4,8

YØUR PRØDUCT SHØULD BE:        32


NEXT PRØBLEM?6,8

YØUR PRØDUCT SHØULD BE:        48


NEXT PRØBLEM?7,6

YØUR PRØDUCT SHØULD BE:        42


NEXT PRØBLEM?9,3

YØUR PRØDUCT SHØULD BE:        27


NEXT PRØBLEM?6,5

YØUR PRØDUCT SHØULD BE:        30


NEXT PRØBLEM?1,4

YØUR PRØDUCT SHØULD BE:        4


NEXT PRØBLEM?7,4

YØUR PRØDUCT SHØULD BE:        28


IF YØU HAVE DØNE WELL ØN THESE PRØBLEMS AND FEEL
CØNFIDENT ABØUT FINDING PRØDUCTS ØF THIS TYPE THEN CALL
 MULTT1*** .  THIS IS A TEST.  IF YØU NEED MØRE PRACTICE
CALL  MULTP1***  FØR MØRE PRØBLEMS.
```

```
MULTT1     11:06   WED.    10-20-76

THIS PRØGRAM WILL TEST YØU TØ FIND ØUT HØW WELL YØU CAN
FIND PRØDUCTS ØF NUMBERS.

WHAT IS YØUR NAME?JØE

DØ YØU NEED INSTRUCTIØNS, JØE?YES

WHEN THE CØMPUTER GIVES YØU A PRØBLEM, JØE, YØU MAY USE A
PIECE ØF SCRATCH PAPER TØ FIND THE INFØRMATIØN THAT THE
CØMPUTER ASKS FØR.  THE CØMPUTER WILL KEEP CØUNT ØF YØUR
SCØRE AND WILL GIVE YØU A GRADE AT THE END.  YØU SHØULD THEN
TAKE THIS GRADE TØ YØUR TEACHER.


FIND THE FØLLØWING PRØDUCT THEN TYPE YØUR ANSWER AND
PRESS RETURN:

                                8 *  9        ?72
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   9 *  3        ?27
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   2 *  4        ?5
YØUR ANSWER IS NØT CØRRECT, JØE.  IT SHØULD BE 8

TRY ANØTHER PRØBLEM:            4 *  5        ?20
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   2 *  1        ?2
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   8 *  3        ?24
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   6 *  6        ?36
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   8 *  4        ?32
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   8 *  7        ?56
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                   9 *  2        ?18
CØRRECT.  VERY GØØD.  10 PØINTS.


YØU HAVE CØMPLETED THE TEST AND YØUR SCØRE IS 90

IF THIS IS NØT A SATISFACTØRY GRADE, JØE, SEE YØUR TEACHER
ØR CALL  MULTP1***  AGAIN.
```

Now let us take a quick look at some other sets.

First: Addition of algebraic expressions. In this set, Joe scored 100 on the test and you see how the computer congratulates him.

```
ADDNPR    11:16   WED.   10-20-76

ADD THE ALGEBRAIC EXPRESSIONS IN THE FOLLOWING PROBLEMS,
THEN CALL  ADDNCK***  AND CHECK YOUR ANSWERS.

1.    -3A +  -2B
      -5A +  -1B
      -----------

2.     3A +  -3B +  -3C
       2A +  -5B +   2C
      ------------------

3.    -5X↑2 +  -5X +  -5
      -2X↑2 +  -3X +   3
      -------------------

4.    -5X↑2 +   2X +   4
      -4X↑2 +   3X +  -2
      -------------------

5.    -2A +   1B
       5A +  -4B
      -5A +   5B
      -----------

6.    -4X↑2 +  -4X +  -2
      -3X↑2 +  -1X +   1
       1X↑2 +   1X +   2
      -------------------
```

```
ADDNCK    11:19   WED.    10-20-76

THIS PRØGRAM WILL CHECK THE ANSWERS TØ THE 6 PRØBLEMS YØU
WERE GIVEN BY THE PRØGRAM  ADDNPR*** .

DØ YØU NEED INSTRUCTIØNS?YES

IN ANSWER TØ THE QUESTIØN 'WHAT ARE THE CØEFFICIENTS IN
PRØBLEM 1?', IF THE PRØBLEM WERE:

                 3A + -4B
                -2A +  1B
                ----------

YØU WØULD TYPE 3,-4,-2,1 (IN THAT ØRDER) AND PRESS
RETURN.  THE CØMPUTER WØULD THEN GIVE YØU THE CØRRECT
ANSWER.


WHAT ARE THE CØEFFICIENTS IN PRØBLEM 1 ?-3,-2,-5,-1

YØUR ANSWER SHØULD BE:          -8 A + -3 B


WHAT ARE THE CØEFFICIENTS IN PRØBLEM 2 ?3,-3,-3,2,-5,2

YØUR ANSWER SHØULD BE:           5 A + -8 B + -1 C


WHAT ARE THE CØEFFICIENTS IN PRØBLEM 3 ?-5,-5,-5,-2,-3,3

YØUR ANSWER SHØULD BE:          -7 X↑2 + -8 X + -2


WHAT ARE THE CØEFFICIENTS IN PRØBLEM 4 ?-5,2,4,-4,3,-2

YØUR ANSWER SHØULD BE:          -9 X↑2 +  5 X +  2


WHAT ARE THE CØEFFICIENTS IN PRØBLEM 5 ?-2,1,5,-4,-5,5

YØUR ANSWER SHØULD BE:          -2 A +  2 B


WHAT ARE THE CØEFFICIENTS IN PRØBLEM 6 ?-4,-4,-2,-3,-1,1,1,1,2

YØUR ANSWER SHØULD BE:          -6 X↑2 + -4 X +  1

IF YØU HAVE DØNE WELL ØN THESE PRØBLEMS AND FEEL
CØNFIDENT ABØUT FINDING SUMS ØF ALGEBRAIC EXPRESSIØNS
THEN CALL  ADDNT1*** .  THIS IS A TEST ØN THIS TYPE
ØF PRØBLEM.  IF YØU NEED MØRE PRACTICE RECALL
 ADDNPR***  FØR MØRE PRØBLEMS.
```

```
ADDNT1     11:23    WED.    10-20-76

THIS PRØGRAM WILL TEST YØU TØ FIND ØUT HØW WELL YØU CAN
ADD ALGEBRAIC EXPRESSIØNS.

WHAT IS YØUR NAME?JØE

DØ YØU NEED INSTRUCTIØNS, JØE?NØ


ADD THE FØLLØWING ALGEBRAIC EXPRESSIØNS THEN TYPE THE
CØEFFICIENTS IN YØUR ANSWER AND PRESS RETURN:

                                1.   -2A +   5B
                                     -5A +  -4B
                                     -----------


WHAT ARE THE CØEFFICIENTS IN YØUR ANSWER?-7,1

YØUR ANSWER IS CØRRECT.  20 PØINTS.

NEXT PRØBLEM:                   2.    5A +  -3B +   2C
                                     -1A +  -5B +  -2C
                                     ------------------


WHAT ARE THE CØEFFICIENTS IN YØUR ANSWER?4,-8,0

CØRRECT.  VERY GØØD.  20 PØINTS.

NEXT PRØBLEM:                   3 . -4X↑2 +  -3X +   3
                                     1X↑2 +   3X +   1
                                     ------------------


CØEFFICIENTS?-3,0,4

CØRRECT.  GØØD WØRK, JØE.  20 PØINTS.

NEXT PRØBLEM:                   4 .  1X↑2 +  -3X +  -4
                                    -1X↑2 +   1X +  -5
                                     ------------------


CØEFFICIENTS?0,-2,-9

CØRRECT.  GØØD WØRK, JØE.  20 PØINTS.

NEXT PRØBLEM:                   5 .  1X↑2 +  -5X +  -2
                                    -3X↑2 +   5X +   5
                                     ------------------


CØEFFICIENTS?-2,0,3

CØRRECT.  GØØD WØRK, JØE.  20 PØINTS.

YØU HAVE CØMPLETED THE TEST AND YØUR SCØRE IS 100

EXCELLENT WØRK, JØE
```

Second: Find the slope of the line segment joining pairs of coordinates.

You will note that Joe did not request instructions in the check program or the test - he evidently knew what to do.

```
ANALP2     11:41    WED.    10-20-76

FIND THE SLØPE ØF THE LINE SEGMENT JØINING THE FØLLØWING
PAIRS ØF CØØRDINATES. THEN CALL  ANALC***  TØ CHECK
YØUR ANSWERS.

  1.    [-6, 7] , [-2, 4]        6.    [-6, 3] , [ 5, 0]
  2.    [-9, 6] , [-4, 7]        7.    [ 5, 0] , [-5,-4]
  3.    [-2,-5] , [ 8, 3]        8.    [ 3,-3] , [-6,-5]
  4.    [ 5, 6] , [ 2, 5]        9.    [-9,-5] , [ 4, 3]
  5.    [-6, 8] , [ 1, 0]       10.    [-6, 5] , [-4,-5]

GIVE YØUR ANSVER IN DECIMAL FØRM.
CØRRECT TØ 2 DECIMAL PLACES.
```

```
ANALC2    08:50   THU.   10-21-76

THIS PROGRAM WILL CHECK YOUR ANSWERS TO THE PROBLEMS
GIVEN YOU BY THE PROGRAM  ANALP2*** .

DO YOU NEED INSTRUCTIONS?NO


WHAT ARE THE COORDINATES IN THE FIRST PROBLEM ?-6,7,-2,4
YOUR SLOPE SHOULD BE  -.75

NEXT PROBLEM?-9,6,-4,7
YOUR SLOPE SHOULD BE   .20

NEXT PROBLEM?-2,-5,8,3
YOUR SLOPE SHOULD BE   .80

NEXT PROBLEM?5,6,2,5
YOUR SLOPE SHOULD BE   .33

NEXT PROBLEM?-6,8,1,0
YOUR SLOPE SHOULD BE -1.14

NEXT PROBLEM?-6,2,6,0
YOUR SLOPE SHOULD BE  -.17

NEXT PROBLEM?8,0,-8,-4
YOUR SLOPE SHOULD BE   .25

NEXT PROBLEM?3,-3,-6,-5
YOUR SLOPE SHOULD BE   .22

NEXT PROBLEM?-9,-8,4,3
YOUR SLOPE SHOULD BE   .85

NEXT PROBLEM?-8,8,-4,-8
YOUR SLOPE SHOULD BE -4.00

IF YOU HAVE DONE WELL ON THESE PROBLEMS AND FEEL
CONFIDENT ABOUT PROBLEMS OF THIS TYPE, CALL  ANALT2*** .
THIS IS A TEST.  IF YOU NEED MORE PRACTICE, RECALL
 ANALP2*** .
```

```
ANALT2    09:01   THU.   10-21-76

THIS PRØGRAM WILL TEST YØU TØ FIND ØUT HØW WELL YØU
CAN FIND THE SLØPE ØF A LINE SEGMENT.
YØU WILL BE GIVEN THE CØØRDINATES ØF THE END PØINTS ØF THE
LINE SEGMENT.

WHAT IS YØUR NAME (TYPE YØUR NAME AND PRESS  RETURN )?JØE

DØ YØU NEED INSTRUCTIØNS, JØE?NØ


HERE IS THE FIRST PRØBLEM:     (-6,-6) , (-1, 2)
?1.6
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                  (-8, 8) , (-6, 5)
?-1.5
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                  (-4, 9) , (-6,-8)
?1
YØUR ANSWER IS INCØRRECT, JØE.  IT SHØULD BE  9.5

TRY ANØTHER PRØBLEM:           ( 2,-7) , ( 7, 6)
?2.6
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                  ( 5,-9) , (-3,-8)
?1
YØUR ANSWER IS INCØRRECT, JØE.  IT SHØULD BE  -.1

TRY ANØTHER PRØBLEM:           (-4, 9) , (-7, 1)
?2.67
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                  (-7,-7) , (-3,-9)
?-.5
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                  ( 3, 4) , ( 5, 1)
?-1.5
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                  ( 7,-5) , ( 6, 6)
?-11
CØRRECT.  VERY GØØD.  10 PØINTS.

NEXT PRØBLEM:                  ( 1, 1) , ( 7, 6)
?1
YØUR ANSWER IS INCØRRECT, JØE.  IT SHØULD BE  .8


YØU HAVE CØMPLETED THE TEST AND YØUR SCØRE IS  70

IF THIS IS NØT A SATISFACTØRY GRADE, JØE, SEE YØUR
TEACHER ØR CALL  ANALP2***  FØR MØRE PRACTICE.
```

Lastly: Find the rational roots of second and third degree polynomial equations. In this set you will note that the check program provides the student with information (the "possible" roots) leading to the "actual" roots.

```
RATRP2    09:15    THU.    10-21-76

FIND ALL RATIØNAL RØØTS ØF THE FØLLØWING EQUATIØNS, THEN
CALL  RATRC2***  TØ CHECK YØUR ANSWERS.

1.     -4X↑2 +  -4X +  -1 = 0

2.     -4X↑3 +   4X↑2 +   7X +   2 = 0

3.     -2X↑3 +   2X↑2 +   3X +   2 = 0
```

```
RATRC2    09:21   THU.   10-21-76

THIS PROGRAM WILL CHECK YOUR ANSWERS TO THE PROBLEMS
GIVEN TO YOU BY THE PROGRAM  RATRP2*** .

DO YOU NEED INSTRUCTIONS?YES

IN ANSWER TO THE QUESTION, 'WHAT ARE THE COEFFICIENTS
AND CONSTANT IN THE FIRST PROBLEM?', IF THE PROBLEM WERE
 -3X↑2 + 2X + 5 = 0 , YOU WOULD TYPE  -3,2,5  AND PRESS
 RETURN .  THE COMPUTER WILL THEN GIVE YOU THE CORRECT
ANSWER.

DO YOU WANT A LIST OF POSSIBLE ROOTS AS WELL AS A LIST
OF ACTUAL ROOTS?YES


WHAT ARE THE COEFFICIENTS AND CONSTANT IN THE
FIRST PROBLEM?-4,-4,-1

THE POSSIBLE RATIONAL ROOTS ARE:

   THE POSITIVE AND NEGATIVE VALUES OF:

 1  / 1          1  / 2          1  / 4

THE RATIONAL ROOTS OF THE EQUATION ARE:

                -.5             -.5


NEXT PROBLEM?-4,4,7,2

THE POSSIBLE RATIONAL ROOTS ARE:

   THE POSITIVE AND NEGATIVE VALUES OF:

 1  / 1          2  / 1          1  / 2          1  / 4

THE RATIONAL ROOTS OF THE EQUATION ARE:

                2               -.5             -.5


NEXT PROBLEM?-2,2,3,2

THE POSSIBLE RATIONAL ROOTS ARE:

   THE POSITIVE AND NEGATIVE VALUES OF:

 1  / 1          2  / 1          1  / 2

THERE ARE NO RATIONAL ROOTS.


IF YOU HAVE DONE WELL ON THESE PROBLEMS AND FEEL
CONFIDENT ABOUT WORKING THIS TYPE OF PROBLEM, THEN
CALL  RATRT2*** .  THIS IS A TEST.  IF YOU NEED MORE
PRACTICE, CALL  RATRP2***  AGAIN.
```

```
RATRT2     10:05    THU.    10-21-76

THIS PRØGRAM WILL TEST YØU TØ FIND ØUT HØW WELL YØU CAN
FIND RATIØNAL RØØTS ØF PØLYNØMIAL EQUATIØNS.

WHAT IS YØUR NAME?JØE

DØ YØU NEED INSTRUCTIØNS, JØE?YES

WHEN THE CØMPUTER GIVES YØU A PRØBLEM, JØE, YØU MAY USE A
PIECE ØF SCRATCH PAPER TØ FIND THE INFØRMATIØN THAT THE
CØMPUTER ASKS FØR.  THE CØMPUTER WILL KEEP CØUNT ØF YØUR
SCØRE AND WILL GIVE YØU A GRADE AT THE END.  YØU SHØULD THEN
TAKE THIS GRADE TØ YØUR TEACHER.

IN ANSWER TØ THE QUESTIØN, 'HØW MANY RØØTS DØ YØU HAVE?',
IF YØUR RØØTS WERE  -2,1,1 , YØU WØULD TYPE  3  AND PRESS
 RETURN . IN ANSWER TØ THE QUESTIØN, 'WHAT ARE YØUR RØØTS?',
YØU WØULD TYPE  -2,1,1  AND PRESS  RETURN .  GIVE YØUR
RØØTS CØRRECT TØ TWØ DECIMAL PLACES.
```

```
RATRT?    10:07    THU.    10-21-76

THIS PRØGRAM WILL TEST YØU TØ FIND ØUT HØW WELL YØU CAN
FIND RATIØNAL RØØTS ØF PØLYNØMIAL EQUATIØNS.

WHAT IS YØUR NAME?JØE

DØ YØU NEED INSTRUCTIØNS, JØE?NØ


FIND THE RATIØNAL RØØTS ØF THE FØLLØWING EQUATIØN:
                        2X↑2 +   7X +   3 = 0

HØW MANY RATIØNAL RØØTS DØ YØU HAVE?2

WHAT ARE YØUR RØØTS?-.5,-3
CØRRECT.  VERY GØØD.  20 PØINTS.


NEXT PRØBLEM:
                        -9X↑2 +  15X +  -6 = 0

HØW MANY RATIØNAL RØØTS DØ YØU HAVE?2

WHAT ARE YØUR RØØTS?.67,1
CØRRECT.  VERY GØØD.  20 PØINTS.


NEXT PRØBLEM:
                        -4X↑3 +   8X↑2 +  -1X +  -3 = 0

HØW MANY RATIØNAL RØØTS DØ YØU HAVE?3

WHAT ARE YØUR RØØTS?-.5,1.5,1
CØRRECT.  VERY GØØD.  20 PØINTS.


NEXT PRØBLEM:
                        -18X↑3 +   9X↑2 +   5X +  -2 = 0

HØW MANY RATIØNAL RØØTS DØ YØU HAVE?3

WHAT ARE YØUR RØØTS?-.5,.67,.33
CØRRECT.  VERY GØØD.  20 PØINTS.


NEXT PRØBLEM:
                        -9X↑3 + -42X↑2 + -51X + -18 = 0

HØW MANY RATIØNAL RØØTS DØ YØU HAVE?3

WHAT ARE YØUR RØØTS?-3,-.67,-1
CØRRECT.  VERY GØØD.  20 PØINTS.


YØU HAVE CØMPLETED THE TEST AND YØUR SCØRE IS 100

EXCELLENT WØRK, JØE
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These "sets of three" are used very effectively in relation to class assignments

1) where the test is handed in;

2) with students requiring additional practice;

3) voluntarily by students preparing for a classroom test. If a good score can be made on the "set of three" test, then it is likely that the student will do well on his classroom test.

If a student does not do well on a "set of three" test, he can always take the test again (he will have a different set of problems). There is no objection to this because he is getting more practice. In fact there is much motivation here. Students, dissatisfied with their grade, will repeat the test until they have made 100 or some other grade that they regard as satisfactory.

And now a word about the teacher in relation to programs such as these. Many schools having access to a computer have "reluctant teachers" - teachers who are reluctant to make use of the computer. This, of course, is usually due to insecurity and lack of knowledge. The "sets of three" can be used very effectively with the absolute minimum of training - in fact, as long as the student can log on, call a program, and log off, the teacher is in business. Teachers normally would want to know how to do this themselves and usually to know a little more about what is going on. But, with the minimum of training for the teacher, these programs will support any text, teacher, or student. There is no requirement to follow a prescribed course determined by the programs - as in computer managed instruction. Any teacher can make immediate use of these "sets of three" or this MATHPACK - as the package is being called.

Ideally, these programs can free the teacher to teach while assignment of problems (each student having his own), checking of work, assigning tests (each student having his own) and grading, are handled by the computer with a few learning experiences thrown in (for example, instant feedback of correct answers.) And why "ideally"? Only because most schools would require more terminals than are currently available.